RESEARCH IMPLEMENTATION REPORT

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STAP Number		Contract Number	EA	Performance Period
		59A0337 [Task #2]	680856	March 2002 – June 2006
Report Date	Report No.	Report Title		
June 2004	SSRP 2006/21	A Simplified Method for Prediction of Long-Term PreStress Loss in Post-Tensioned Concrete Bridges		
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Abstract

Creep and shrinkage of concrete and relaxation of prestressing steel can cause time-dependent changes in the stresses and strains of concrete structures. These changes result in continuous reduction of the concrete compression stresses and in the prestressing steel tensile stresses. A reasonably accurate estimate of the long-term prestress losses is needed to avoid serviceability problems, such as cracking or excessive deflection. An analytical method is presented to predict the long-term prestress losses in continuous cast-in-place post-tensioned bridges. The method is based on the basic principles of solid mechanics and satisfies the requirements of equilibrium and compatibility of the bridge cross section. The proposed method for a section of a concrete girder reduces to a single equation with three coefficients, which are functions of the modulus of elasticity and creep coefficient of concrete, location and amount of prestressing and non-prestressed steel, and geometry of the cross section. To expedite the use of the method and to make it more appealing to practicing engineers, design aids are provided to estimate these three coefficients. The method is further extended to continuous bridge girders by using the force method to calculate the change in connecting moments at intermediate supports and hence the increase or decrease in prestressing losses. It is shown that the present empirical equations of the bridge standards can overly underestimate or overestimate the long-term prestress losses, depending on the concrete creep and shrinkage properties as well as prestressing and non-prestressed steel ratios.

Achievement

An analytical method is presented to predict the long-term prestress losses in continuous cast-in-place post-tensioned bridges. The proposed method for a section in concrete girder reduces to a single equation with three coefficients, which are functions of the modulus of elasticity and creep coefficient of concrete, location and amount of prestressing and non-prestressed steel, and geometry of the cross section. To expedite the use of the method, design aids are provided to estimate these three coefficients.

Conclusion & Recommendation

The prediction of long-term prestress losses from equations that are a function of only one or two parameters, as in the case of all the equations of bridge codes, cannot produce accurate results for all cases.

Results from equations for prestress losses that are functions of only the relative humidity can be misleading. It is recommended that the predictive equations be functions of the creep and shrinkage coefficients as determined from codes of practice.

Accounting for the effect of non-prestressed steel is very essential to produce reliable results for prestressing losses. Neglecting this effect, as in the case of the CEB-FIP method, can greatly overestimate the prestress losses. Taking this effect into account in an empirical fashion, as in the case of the other predictive equations, can produce predictions that do not follow the actual trend of prestress loss.

The AASHTO-LRFD upper bound approximate method is in fact a lower bound. The approximate average method lies outside the range of prestress loss predictions. The CHBDC gives better predictions for prestress losses compared with AASHTO-LRFD and CEB-FIP methods.

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Implementation Recommendations

- Validate methodology with data from bridges in-service.

Implementation Measures Taken

- Work has been initiated under RTA #59A0420 to validate this method using data from bridges in-service.